Low vitamin D in Tasmania

Key messages for health professionals

Vitamin D is essential for musculoskeletal health in all age groups and is likely to be important for other aspects of health. Vitamin D maintains calcium and phosphate levels to support bone health and muscle function. Serum 25-hydroxy vitamin D (25(OH)D) is used to measure vitamin D status. Adequate levels of vitamin D are ≥ 50 nmol/L in adults and children (1).

Classification of vitamin D (25(OH)D) levels in adults and children	
Adequacy	≥ 50 nmol/L
Mild deficiency	30–49 nmol/L
Moderate deficiency	12.5–29 nmol/L
Severe deficiency	≤ 12.5 nmol/L

Vitamin D deficiency

Vitamin D deficiency can cause bone and muscle pain and poor bone mineralisation. Severe vitamin D deficiency can result in rickets in children and osteomalacia in adults. Low vitamin D may contribute to osteopenia and osteoporosis. Vitamin D supplementation, in combination with calcium, reduces the risk of falls and fractures and increases bone mineral density in older people.

Epidemiological evidence shows an association between serum concentrations of 25-hydroxyvitamin D (25(OH)D) and a variety of disorders, including metabolic, cardiovascular, malignant, autoimmune, infectious diseases, as well as all-cause mortality, however, causal links are still being established (2). Vitamin D plays a role in immunity and inflammatory pathways (3). Studies have shown an inverse association between 25(OH)D concentration and acute respiratory tract infection (4), with suggestive evidence of causal links between vitamin D and both viral (5) and bacterial respiratory infections (6). Areas with high UV radiation are associated with a reduced risk of multiple sclerosis, with Mendelian randomised studies suggesting this may be partly due to vitamin D (7).

Low vitamin D is an important public health issue and is common in Tasmania. An analysis of five Tasmanian epidemiological studies from 1997 to 2004/05 found one third of Tasmanian adolescents and adults were vitamin D deficient in summer/autumn and two thirds in winter/spring (8). The 2011–13 Australian Health Survey (AHS) has provided the most comprehensive measure of vitamin D status in Australians aged 12 years and over (9). The survey found just under one in four adults (23 per cent) (10), 32 per cent of young adults aged 18–24 and 17 per cent of adolescents aged 12–17 years were vitamin D deficient (11). Deficiency was more common in winter and in southern parts of Australia (latitude >35˚S) (12). For Tasmanian adults, the AHS indicated that 14 per cent were vitamin D deficient in summer and 43 per cent in winter (10).

The major source of vitamin D in Australia is skin exposure to the sun's ultraviolet-B (UVB) radiation. Vitamin D production changes seasonally, decreasing in winter when UV levels are lower, more time is spent indoors and more clothing is worn. Most Australians get less than 10 per cent of their vitamin D requirements from dietary sources (13). Some foods naturally contain vitamin D for example, oily fish (salmon, sardines and tuna), butter and eggs. Vitamin D is added to some foods (for example margarines, some dairy/soy products and some breakfast cereals), other foods are treated to increase vitamin D (for example UV-treated mushrooms).

People at risk of low vitamin D

- **People with naturally dark skin** (Fitzpatrick skin type V/VI, (14)). The pigment in skin (melanin) is a filter to UVB radiation and reduces the synthesis of vitamin D in the skin.
- **People with little or no sun exposure.** This includes:
    - Older adults and others who are housebound, hospitalised or institutionalised long term.
    - People who wear covering or concealing clothing for religious or cultural reasons, or to protect their skin.
    - People who avoid sun exposure, due to high risk of skin cancer, previous skin cancer or are on photosensitising medication.
    - People who work in occupations with limited sun exposure (for example office workers, and night shift workers).
- **People with medical conditions or medications affecting vitamin D metabolism,** including:
    - end stage liver disease
    - renal disease
    - hyperparathyroidism
    - fat malabsorption (eg cystic fibrosis, coeliac disease, inflammatory bowel disease, gastrectomy)
    - drugs that increase degradation such as rifampicin and some anticonvulsants.
- **People with a BMI >30 kg/m2.** People in larger bodies will need higher doses to achieve adequacy, but the same maintenance dose (15).
- **Exclusively breastfed babies who fall into a risk category above or have mothers with low vitamin D.** Breastmilk contains little vitamin D. Infants depend on maternal stores for the first few months of life (16). Infant formula is fortified with vitamin D. Infants are at risk of low vitamin D if their mothers have low vitamin D. Lactating mothers with vitamin D deficiency should take supplements (see below for further details).

Sun exposure and vitamin D

Vitamin D recommendations need to balance the risk of skin damage, skin cancer and vitamin D deficiency. A safe level of UV exposure that allows vitamin D synthesis without increasing skin cancer risk is not known. Direct skin exposure to sunlight is required for vitamin D synthesis as UVB does not pass-through glass. For people at high risk of skin cancer, including those with fair skin type (Fitzpatrick skin type I and II), a personal history of skin cancer, a family history of melanoma, the presence of many naevi (moles), or are immunocompromised/ having immunosuppressive therapy, supplements are likely to be safer to maintain vitamin D levels (3).

People who work outdoors are at higher risk of skin cancer as they have extended periods of sun exposure. Vitamin D deficiency is less likely to be an issue for this group and they may need sun protection all year, when UV levels are greater than three (for example clothing, sunscreen, shade,

sunglasses). UV levels can be found on the Bureau of Meteorology or SunSmart apps. Exposing as much skin as possible to the sun maximises vitamin D production in the shortest amount of time. In winter, being physically active outdoors can help with skin exposure.

Table 1. Recommended sun exposure in Tasmania to reduce the risk of low vitamin D (adapted from references (3, 13, 17, 18))

	Fair to olive skin Fitzpatrick skin types I–IV Higher risk of skin cancer	**Naturally very dark skin** Fitzpatrick skin types V–VI rarely or never burns Higher risk of low vitamin D
From September to April – when average daily UV levels are 3 and above	Recommended **sun exposure**: Regular (1–2 times/day) Short (5–10 minutes) Sun exposure mid-morning or mid-afternoon (when UV levels are <3), each day to arms and hands (or equivalent area of skin) without sun protection measures. Avoid the middle of the day when UV levels are higher.	Recommended **sun exposure** Regular (1–2 times/day) Longer (> 30 minutes) Sun exposure mid-morning or mid-afternoon, when UV levels are <3, each day to as much skin as possible, without sun protection measures. It may not be possible to maintain vitamin D levels through sun exposure alone and supplementation may be required.
	Sun protection (clothing, sunscreen, broad-brimmed hat, shade and sunglasses) is recommended when outdoors for more than a few minutes when UV levels ≥3.	**Sun protection** (clothing, sunscreen, broad-brimmed hat, shade and sunglasses) is recommended when outdoors for extended periods when UV levels are ≥3.
From May to August – when average daily UV levels are below 3	Recommended **sun exposure**: In the middle of the day Longer (> 30 min) Spend > 30 minutes outdoors in the middle of the day, with as much skin as possible uncovered on most days of the week. If adequate sun exposure is not possible supplementation may be required.	Recommended **sun exposure**: In the middle of the day Longer (> 60 min) Spend > 60 minutes outdoors in the middle of the day with as much skin as possible uncovered on most days of the week. It may not be possible to maintain vitamin D levels through sun exposure alone. Supplementation is most likely to be required.
	Sun protection is not needed (except sunglasses) unless in alpine regions, outside for extended periods (≥2 hours) or near highly reflective surfaces (for example snow or water).	**Sun protection** is not needed (except sunglasses) unless in alpine regions, outside for extended periods or near highly reflective surfaces (for example snow or water).

Note: Fitzpatrick skin phototype is a commonly used system to describe a person's skin type in terms of response to ultraviolet radiation exposure, FitzpatrickSkinType.pdf (arpansa.gov.au).

Most Tasmanians with fair to olive skin (Fitzpatrick skin type I–IV) get enough vitamin D through incidental sun exposure from September to April, when UV levels are high, and more time is spent outdoors. Vitamin D levels are likely to be maintained in the warmer months, with five to 10 minutes of sun exposure mid-morning and mid-afternoon on most days (13). From May to August, when UV is lower, it is harder for Tasmanians to get enough vitamin D through incidental sun exposure. In the colder months, greater than 30 minutes of sun exposure is required, in the middle of the day, to as much skin as possible, on most days (13). The additional time required for people with darker skin (Fitzpatrick skin types V and VI) to produce adequate vitamin D is unclear (3) and has been estimated to be 2– 8 times more sun exposure (3).

Recommendations for testing 25(OH)D levels

- **Routine screening** for vitamin D is **not** recommended (1).
- **Testing is recommended** for **adults and children at risk of low vitamin D**, including pregnant or lactating women with risk factors (see people at risk of low Vitamin D above). Exclusively breastfed babies with risk factors of low vitamin D can commence treatment prior to testing.
- **Testing is required** for people presenting with clinical issues associated with vitamin D deficiency. Including:
    - osteomalacia, rickets, osteoporosis or osteopenia,
    - unexplained proximal limb or muscle pain,
    - unexplained bone pain or other evidence suggesting metabolic bone disease, and
    - unexplained raised serum alkaline phosphatase, or low serum calcium or phosphate.
- **Consider testing siblings** of children with moderate to severe vitamin D deficiency.

Treatment guidelines

- **Treatment is recommended if serum 25(OH)D levels are < 50 nmol/L** (13).
- **For mild deficiency (30–49 nmol/L)** safe sun exposure (when UV levels are less than 3) is recommended as first line treatment (19), where this is practical to increase vitamin D levels (likely not to be possible in winter), see above and table 1 for sun exposure recommendations.
- **For those with moderate (12.5-29 nmol/L) and severe deficiency (≤ 12.5 nmol/L), and for those with mild deficiency where safe sun exposure is not practical, vitamin D supplementation is recommended.** Evidence that supplementation improves outcomes for mild deficiency is limited and inconsistent, but unlikely to cause harm (19).
- **Supplementation without testing** may be appropriate for those at **high risk of vitamin D deficiency**, after clinical consideration and considering access and adherence to testing.
- **For people starting treatment for osteoporosis, supplementation is recommended** (unless levels are ≥ 75 nmol/L).
- The treatment target is ≥ 50 nmol/L (13) and ≥ 75 nmol/L for people with osteoporosis (18).
- Vitamin D (25(OH)D) has a long half-life, in theory higher concentrations prior to winter may prevent winter deficiency. However, the pre-winter 25(OH)D concentration required to prevent deficiency is unclear, as is the dose of UV radiation required to both meet daily requirements and increase the 25(OH)D from the winter low to the required pre-winter level (20). It is recommended to aim for vitamin D maintenance throughout the year rather than ‘stockpiling’ prior to winter (20).

- **Higher doses taken less frequently** (for example monthly) may improve adherence, but there may be an increase in dosing errors and **are not routinely recommended as first line treatment** (19).
- High dose vitamin D (50 000 IU monthly) **should not be used**, during pregnancy or lactation, or in infants less than 3 months, or in older people. It may have adverse effects and may not be as effective as daily doses. Asymptomatic vitamin D deficiency does not need to be corrected rapidly.
- **It is not recommended to prescribe a single dose of more than 50 000 IU (1.25 mg) of vitamin D for adults**. Contraindications to high-dose vitamin D include hypercalcaemia and kidney disease.
- **Once supplementation has commenced wait at least three months before retesting** serum 25(OH)D (1).
- **Vitamin D absorption is affected by many factors,** including weight, medical conditions and drug interactions. The dosage required to correct deficiency varies between patients.
- **Cod liver oil capsules are not a suitable alternative,** as they typically contain 60–85 IU (1.5–2.1 µg) of vitamin D_3 per capsule, but 8–10 times more vitamin A per capsule. The number of capsules required to meet adequate daily vitamin D would exceed the recommended daily intake for vitamin A and may lead to toxicity.
- **Adequate calcium is important at all ages.** Encourage adequate intake of foods high in calcium including milk, yoghurt, cheese and calcium fortified dairy alternatives (21) or supplementation if necessary. Those with significant muscular skeletal disease (osteopenia + fracture or osteoporosis) may need supplementation if their dietary intake is low.
- **Low vitamin D is a long-term problem for at-risk people.** Once vitamin D is treated the aim is to maintain levels of 25(OH)D between 50–100 nmol/L. People with risk factors for low vitamin D are likely to need lifelong daily supplements.
- **Solariums are banned in Tasmania,** except for medical purposes, and should not be used to increase vitamin D levels as they emit dangerous levels of UV that increase the risk of skin cancer.

Table 2: Adult dosing schedule (adapted from: (17))

25(OH)D level nmol/L	**Alternative adult dosing**	
	Daily dose oral vitamin D3*	High dose regimen oral vitamin D3*#
30–49 (mild deficiency)	1 000–2 000 IU (25–50 µg) daily	7 000–14 000 IU (175–350 µg) weekly
<30 (moderate to severe deficiency)	Initially 3 000–5000 IU (75–25 µg) daily for at least six to 12 weeks Recheck level after three months. If levels 30–49 nmol/L change to therapy for mild deficiency	

*Calcium intake of 1 000–1 300 mg/day is also recommended

#Not readily available in Australia. Medical practitioner can obtain TGA authorisation to treat patient with high dose vitamin D. Alternatively practitioner may write a prescription for a compounding pharmacy.

No safe upper level of 25(OH)D has been identified. Although there is a lack of knowledge about levels of vitamin D that could be harmful, serum 25(OH)D **levels above 125 nmol/L should be avoided** due to lack of knowledge of long-term safety (22).

Treatment guidelines for pregnancy, breastfeeding and infants/ children

- Vitamin D sufficiency during pregnancy is important to ensure the foetus has sufficient vitamin D and is not born deficient (23).
- Pregnant women should have their vitamin D levels tested (between 7-10 weeks), especially those with risk factors for deficiency (18).
- **Pregnant women** with levels 30–49 nmol/L should **commence 1 000 IU/day**, for those with levels **<30 nmol/L commence 2000 IU/day** (18). Retest levels at 28 weeks gestation (18).
- **All pregnant women, including those at lower risk of vitamin D deficiency,** may benefit from a **vitamin D supplement of 400–600 IU** throughout their pregnancy**, especially in the third trimester** (23, 24), when maternal vitamin D is transferred from the placenta to the foetal liver.
- Global consensus recommendations and recent clinical practice guidelines, from the USA recommend ~~v~~itamin D supplementation during pregnancy, without testing, due to the potential to reduce the risk of preeclampsia, intra-uterine mortality, Small for Gestation Age, preterm birth, neonatal mortality, large fontanelle size, hypocalcaemia, rickets, and dental enamel issues (2, 25).
- There is inadequate evidence to support high-dose vitamin D supplementation during pregnancy and lactation.
- Breastfeeding is the normal way to feed infants and young children and is unequalled in providing the ideal food for healthy growth and development (21, 26).
- **For breastfeeding women**, who were deficient in pregnancy, continue with 1 000 IU/day while breastfeeding (18).
- There are contradictory views in the literature about universally supplementing **breastfed infants with vitamin D.** A recent review of infant feeding suggested there was insufficient evidence to recommend universal supplementation in Australia (27). While global consensus recommendations recommend universal supplementation for all breastfed infants, specifically to prevent rickets (25).
- **Breastfed infants with risk factors for low vitamin D should be supplemented with 400 IU for the first 12 months of life** (28). This includes infants that have little or no sun exposure (23). It is recommended to wait until breastfeeding is well established (six weeks), before introducing supplements in full term infants (23).
- **Infant formula should provide adequate vitamin D** intake for babies who aren't breastfed unless the infant is vitamin D deficient. If deficient, they require additional treatment (see Table 3 below).
- Check vitamin D adequacy in infants who are fed a mixture of infant formula and breastmilk or who have reduced formula intake after solids are introduced.
- **Children with low calcium, low phosphate or clinical rickets require urgent specialist assessment and further investigation.**

- **Follow up bloods (25(OH)D, Ca, PO_4, ALP and PTH if previously elevated)** may not be required in mild deficiency. Check at one month for infants and three months for those over 12 months (28).
- **In children with ongoing risk factors for low vitamin D annual testing is recommended.** More frequent testing should be avoided. A plan is required to maintain vitamin D and calcium status with behaviour change and supplementation as required (28).
- **Treatment and maintenance doses are intended to ensure 25(OH)D levels ≥ 50 nmol/L.**
- Vitamin D_3 is available from community pharmacies in liquid and chewable tablets**.**
- High dose vitamin D is generally safe for infants older than 3 months, however daily vitamin D is usually preferential as there is less risk of incorrect dosing.

Table 3: Paediatric dosing schedule (adapted from: (28))

25(OH)D level (nmol/L)	**Treatment with oral vitamin D_3**	**Maintenance/prevention in children with ongoing risk factors (oral vitamin D_3)**
Preterm		
30–49 nmol/L	200 IU (5 µg)/kg/day, maximum 400 IU (10 µg) /day	200 IU (5 µg)/kg /day, maximum 400 IU (10 µg)/day
< 30 nmol/L	800 IU (20 µg) daily, review after 1 month	
Young infants (< 3 months)		
30–49 nmol/L	400 IU (10 µg) /day for 3 months	400 IU (10 µg)/kg /day
< 30 nmol/L	1 000 IU (25 µg)/ day for 3 months	
Infants (3-12 months)		
30–49 nmol/L	400 IU (10 µg) /day for 3 months	400 IU (10 µg)/kg /day
< 30 nmol/L	1 000 IU (25 µg)/ day for 3 months or 50 000 IU stat and review after 1 month (consider repeating dose)	
Children and adolescents (1-18 years)		
30–49 nmol/L	1 000–2 000 IU (25–50 µg)/ day for 3 months or 150 000 IU (3.75 mg) stat	400 IU (10 µg)/kg /day or 3 000–4 000 IU weekly or 150 000 IU (3.75 mg) at the start of Autumn
< 30 nmol/L	1 000–2 000 IU (25–50 µg)/ day for 6 months or 3 000–4 000 IU / day for 3 months or 150 000 IU (3.75 mg) stat and repeat at 6 weeks.	

Note: these recommendations are as of 2022 but are subject to change. Clinical Practice Guidelines: Vitamin D deficiency, Royal Children's Hospital Melbourne at Clinical Practice Guidelines: Vitamin D deficiency (rch.org.au).

High dose vitamin D are not readily available in Australia. Medical practitioners can obtain TGA authorisation to treat patients with high-dose vitamin D. Alternatively practitioners may write a prescription for a compounding pharmacy.

Acknowledgements

This document is based on a recent desk top review conducted by PHS and two key documents:

- Low vitamin D in Victoria. Key health messages for doctors, nurses and allied health (2017). Victorian State Government, Health and human Services.
- Low vitamin D in Tasmania. Key health messages for doctors, nurses, pharmacists and allied health professionals (2014). Department of Health and Human Services, Tasmania.

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